

- San Francisco Bay Conservation and Development Commission

LINKAGE WITH OTHER ECOSYSTEM ELEMENTS

Maintenance of grass shrimp populations will be benefitted by other efforts to restore populations of chinook salmon, steelhead, delta smelt, sturgeon, and outflow requirements in the Delta.

OBJECTIVE, TARGETS, AND ACTIONS



The Strategic Objective is to maintain, to the extent consistent with ERP goals, fisheries for striped bass, American shad, signal crayfish, grass shrimp, and nonnative warmwater gamefishes.

SPECIES TARGET: Maintain grass shrimp populations at present levels as a minimum to support the existing commercial fisheries. Determine factors regulating their populations in order to discover if the fisheries conflict with other ecosystem restoration objectives.

LONG-TERM OBJECTIVE: Allow grass shrimp (*Crangon* spp., *Palaemon*) numbers (and harvest) to increase as conditions in the restored estuary favor their reproduction and survival.

SHORT-TERM OBJECTIVES: Maintain grass shrimp populations at present levels as a minimum to support the existing commercial fisheries. Determine factors regulating their populations in order to discover if the fisheries conflict with other ecosystem restoration objectives.

RATIONALE: Grass shrimp are a mixture of native and introduced species that support a small commercial fishery in San Francisco Bay, largely for bait. The relative abundance of the various species as well as their total abundance appears to be tied in part to outflow patterns. It is likely that these abundant shrimp are important in Bay-Delta food webs leading to many other species of interest. The role of these shrimp in the Bay-Delta system and the effects of the fishery on that role need to be investigated.

STAGE 1 EXPECTATIONS: An investigation of the ecological role and requirements of the shrimp species and the effects of the fishery will have been conducted, to find out if any special management for either is needed.

RESTORATION ACTIONS

The target for grass shrimp is to increase the population of grass shrimp above existing levels and eventually increase the commercial fishery within San Francisco and surrounding bays.

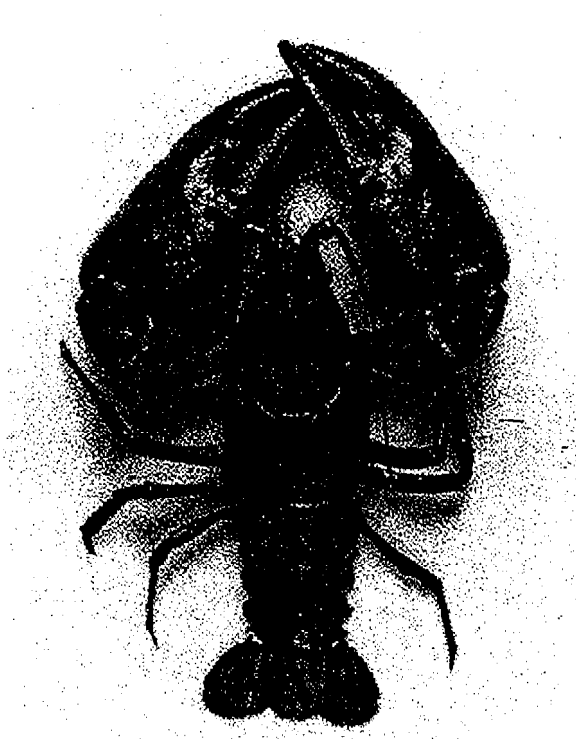
Grass shrimp would benefit from the following restoration activities and actions:

- Determine the interaction and potential effects between mitten crabs and grass shrimp on the commercial fishery.
- Improved and sustain Delta outflow during the March through May period.

REFERENCES

- Strategic Plan for Ecosystem Restoration. 2000. CALFED Bay-Delta Program, Programmatic EIS/EIR Technical Appendix. July 2000.
- WRINT-DFG-Exhibit # 6. 1992. 1992 Water Quality/Water Rights Proceedings in the San Francisco Bay/Sacramento - San Joaquin Delta Estuary Dependent Species.

◆ SIGNAL CRAYFISH



INTRODUCTION

The signal crayfish is an important non-native resident invertebrate of the Central Valley and Delta. It occupies a wide range of habitats from swift large rivers to sluggish backwaters. It currently supports a recreational and an active commercial fishery that in 1977 resulted in over 500,000 pounds of crayfish being harvested. The population appears to be stable since the introduction of fishing regulations that limits the commercial take of any crayfish under 9.2 centimeters total length.

Factors that may limit the signal crayfish's ability to contribute to a healthy Central Valley ecosystem are river and stream flow, aquatic habitat, and competition from recently introduced species (mitten crab).

RESOURCE DESCRIPTION

The signal crayfish was first described in 1852 by the U.S. Exploring Expedition during their west coast expeditions. The signal crayfish was introduced into California waters from Oregon and has spread

throughout Central Valley waterways. Crayfish have been known to estivate for periods of time when fields are dried and then re-flooded at a later date. This process makes them extremely adaptable to drought conditions. Habitat use has been described to not exceed over 3 meters in depth and water conditions from clear cool fast moving water to slow stagnate backwaters. Signal crayfish have also been noted in slightly brackish waters of the western Delta.

Spawning occurs in the fall with the females carrying the eggs over winter and releasing the young of the year in early spring.



VISION

The vision for the signal crayfish is to maintain self-sustaining population of crayfish in order to support recreational and commercial fishing.

A major focus of efforts to maintain the fishery would be to assure that the Sacramento and San Joaquin river flows during the late summer and early fall remain above an established level for that period. Many of the efforts implemented under the Stage 1 Actions to increase tidally influenced and other aquatic habitats will benefit crayfish populations. Increases in shallow-water habitat will provide additional burrowing and foraging areas for the crayfish. Increases in crayfish numbers will provide an increased forage base for sturgeon (green and white), smallmouth bass, and terrestrial species.

Efforts will need to be implemented that look at the interaction among members of the benthic community. Specifically the interaction between crayfish and the recently introduced mitten crab (*Eriocheir sinensis*) will need to be examined.

INTEGRATION WITH OTHER RESTORATION PROGRAMS

Efforts to maintain a sustained population of signal crayfish in the Sacramento and San Joaquin rivers and Delta would also involve cooperation and support from other established programs.

- Water Quality Control Program for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (May 1995).
- California Fish and Game Commission will continue to regulate and develop fishing regulation based on recommendations by the California Department of Fish and Game.

LINKAGE WITH OTHER ECOSYSTEM ELEMENTS

Maintenance of the crayfish population will be benefitted by other efforts to restore populations of chinook salmon, steelhead, delta smelt, sturgeon, and riparian habitats throughout the ERPP service area.

OBJECTIVE, TARGETS, AND ACTIONS



The Strategic Objective is to maintain, to the extent consistent with ERP goals, fisheries for striped bass, American shad, signal crayfish, grass shrimp, and nonnative warmwater gamefishes.

SPECIES TARGET: Maintain signal crayfish populations at present levels, in order to support the existing fisheries.

LONG-TERM OBJECTIVE: Allow signal crayfish numbers (and harvest) to increase gradually as conditions in the restored estuary favor its reproduction and survival. Use harvest and other management measures to ensure that increases in crayfish populations do not jeopardize programs to sustain native species.

SHORT-TERM OBJECTIVE: Maintain signal crayfish populations at present levels, in order to support the existing fisheries.

RATIONALE: The signal crayfish is an introduced species that supports a small commercial fishery, as well as a recreational fishery, in the Delta. It has been established in the Delta for nearly a century and appears to be integrated into the Bay-Delta system, appearing as a major food item for otters and some fish. The signal crayfish has fairly high water quality requirements so its populations will presumably

increase as water quality in the freshwater portions of the Delta improves. Its role in the ecosystem and the effects of the fishery on that role need to be investigated.

STAGE 1 EXPECTATIONS: An investigation of the ecological requirements of the crayfish and the effects of the fishery will have been conducted, to find out if any special management for either is needed.

RESTORATION ACTIONS

The target for signal crayfish is to maintain existing levels and eventually increase both the commercial and recreational fisheries within the Sacramento-San Joaquin Delta.

Signal crayfish would benefit from the following restoration activities and actions:

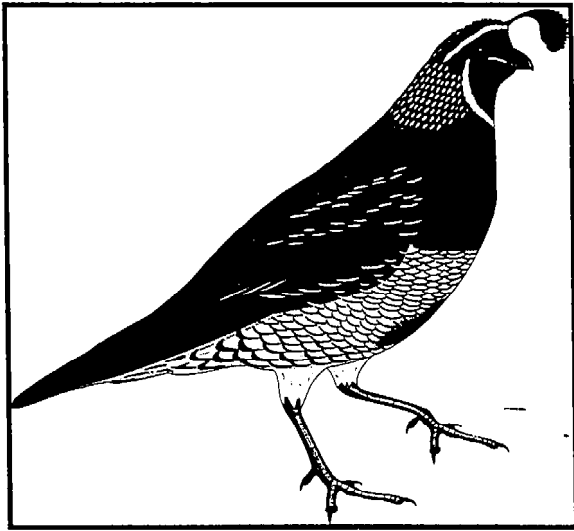
All Ecological Management Zones:

- Determine the interaction and potential effects between mitten crabs and signal crayfish on both the commercial and recreational fisheries.
- Habitat improvements and increases to both riparian and tidally influenced zones.
- Improved and sustained flows in the major rivers and streams of the Central Valley

REFERENCES

- Riegal, J.A. 1959. The systematics and Distribution of Crayfishes in California. In: California Fish and Game; Volume 45, Number 1, pages 29-49.
- Huner, Jay V. 1978. Exploitation of Freshwater Crayfishes in North America. In: Fisheries; Volume 3, Number 6, pages 2-5.
- Strategic Plan for Ecosystem Restoration. 2000. CALFED Bay-Delta Program, Programmatic EIS/EIR Technical Appendix. July 2000.

◆ UPLAND GAME



INTRODUCTION

Upland game species are of high interest to recreational hunters in the Bay-Delta and contribute to California's economy through the sale of hunting-related equipment and hunting-related expenditures. Major factors that limit this resource's contribution to the health of the Delta are related to adverse effects of conversion of native upland habitats for agricultural, industrial, and urban uses, and land use practices that degrade habitats used by these species.

RESOURCE DESCRIPTION

The upland game guild includes those species defined in the California Department of Fish and Game (DFG) hunting regulations as resident and migratory upland game birds and small game. Of the three groups of upland game species that define the guild (Coastal and Central Valley, Mountain Upland, and Eastern Upland), only the coastal and Central Valley group (see table) is addressed in this vision. The montane upland game group includes species that typically inhabit the upper elevations of the Coast Ranges, Cascade Range, and Sierra Nevada. The eastern upland game group includes those species inhabiting the eastern slopes of the Sierra Nevada and eastern high deserts within California.

Upland game species commonly occur in upland habitat types, including agricultural cropland, riparian habitats, and oak woodlands. The ring-necked pheasant and wild turkey are non-native species that have successfully established in the Central Valley and are popular game for hunting. These species occur from the Central Valley floor to the foothills. Native species' population densities, with the exception of the American crow, are currently lower than they were before lands in the Bay-Delta were reclaimed. Native species are an integral part of our heritage, providing recreation and food for thousands of people. Their populations are good indicators of the health and viability of the vegetative communities on which they rely.

Throughout California, upland game habitat has been degraded or lost as a result of some types of land uses, such as logging, land conversion, water projects, intensive farming, overgrazing, and urban encroachment. Wildfires and floods also destroy many acres of nesting and escape cover.



VISION

The vision is to maintain healthy populations of upland game species at levels that can support both consumptive (e.g., hunting) and nonconsumptive (e.g., birdwatching) uses, through protection and improvement of habitats and reduction in stressors.

Protecting and restoring existing and additional suitable riparian habitats and improving management of agricultural lands and reducing the effect of stressors that can suppress breeding success will be critical to maintaining healthy upland game populations in the Bay-Delta. The key to improving populations of upland game will be in providing increased nesting habitat and escape cover. The ERPP's proposed habitat restoration in the Sacramento-San Joaquin Delta and Suisun Marsh/North San Francisco Bay Ecological Management Zones will increase habitat quality and quantity. Restoration will also help maintain healthy populations of upland game species.

Restoring upland game habitat over a range of elevations above Bay-Delta mean-high-tide water levels would allow a greater diversity of plant species to establish. Grassland, woodland, and shrub habitats will be developed, maintained, protected, and restored in those areas that are out of the inundation zones of high water. This will provide an area that will serve as a transition zone which will greatly increase the natural processes necessary for restoring native habitat and plant communities.

Upland game species would also benefit from management strategies that would improve habitat quality. Management strategies should include protecting and maintaining important existing habitat areas and encouraging establishment and maintenance of agricultural and upland habitats used by these species. Such strategies could be implemented through cooperative agreements with land management agencies, landowner incentive programs, or conservation easements with or purchase from willing sellers.

Restoration of ecosystem processes and habitats that allow natural floodplains, meander corridors, seasonal pools, and riparian vegetation to develop will provide habitat for upland game species elsewhere in the Central Valley.

INTEGRATION WITH OTHER RESTORATION PROGRAMS

Groups that are involved in efforts to restore upland game include:

- California Department of Fish and Game wildlife program branch,
- California Department of Fish and Game's Game Bird Heritage Program,
- Pheasants Forever,
- Turkey Federation, and
- Quail Unlimited.

LINKAGE WITH OTHER ECOSYSTEM ELEMENTS

Protection and restoration of upland game species is integrally linked with restoration of riparian,

grassland, and agricultural habitats, as well as improvements in upper watershed health.

OBJECTIVE, TARGETS, AND ACTIONS



The Strategic Objective is to enhance, to the extent consistent with ERP goals, populations of waterfowl and upland game for harvest by hunting and for non-consumptive recreation.

SPECIES TARGET: Increase the populations and distribution of upland game.

LONG-TERM OBJECTIVE: Maintain self-sustaining populations of upland game birds at levels to meet or exceed population levels present during the 1970s.

SHORT-TERM OBJECTIVE: Protect and maintain important existing habitat areas and encourage the maintenance of agricultural and upland habitats used by these species.

RATIONALE: Upland game are supported by diverse agricultural and upland habitats. The key to maintaining these species is by maintaining the habitats upon which they depend.

STAGE 1 EXPECTATIONS: Important upland game habitats will have been identified as well as conditions that reduce habitat quality. Existing habitats will have been protected and, where feasible, agricultural practices will have been adjusted to improve upland game populations.

RESTORATION ACTIONS

The following general targets will assist in meeting the restoration objective:

- Restore grassland, shrub, and woodland habitats,
- Increase upland game populations, and
- Improve hunting opportunities.

The following general programmatic actions will assist in meeting the targets:

- Protect and restore upland habitats.

- Improve land use and agricultural land management to enhance upland game.
- Improve forest and riparian land management for upland game.
- Reduce potential for wildfire in floodplain, riparian forest, grasslands, and forest lands.

REFERENCE

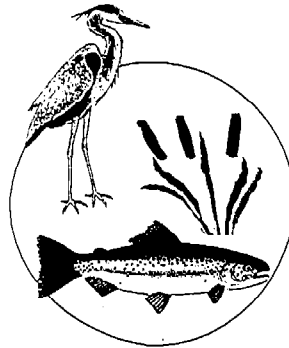
Strategic Plan for Ecosystem Restoration. 2000.
CALFED Bay-Delta Program, Programmatic
EIS/EIR Technical Appendix. July 2000.

Upland Game Species and the Groups in Which They Appear			
Species	Coastal and Central Valley Group	Montane Upland Game Group	Eastern Upland Game Group
Ring-necked pheasant	✓		
California quail	✓		✓
Wild turkey	✓	✓	
Common snipe	✓	✓	✓
Dove	✓	✓	✓
American crow	✓	✓	✓
Tree squirrels	✓	✓	✓
Cottontail/brush rabbit	✓	✓	✓
Black-tailed hare	✓	✓	✓
Band-tailed pigeon	✓	✓	✓
Chukar*		✓	✓
Mountain quail*		✓	✓
Sage grouse*			✓
Blue/ruffed grouse*		✓	
Prairie chicken*		✓	
*These species are not addressed by this vision.			

◆ VISION FOR REDUCING OR ELIMINATING STRESSORS

INTRODUCTION

This section presents visions for stressors that adversely affect important ecosystem elements. Stressors are natural and unnatural events or activities that adversely affect ecosystem processes, habitats, and species. Environmental stressors include water diversions, water contaminants, levee confinement, stream channelization and bank armoring, mining and dredging in streams and estuaries, excessive harvest of fish and wildlife, introduced predator and competitor species, and invasive plants in aquatic and riparian zones. Some major stressors affecting the ecosystem are permanent features on the landscape, such as large dams and reservoirs that block transport of the natural supply of woody debris and sediment in rivers or alter unimpaired flows. Reducing the adverse effects of stressors is a major component in the Ecosystem Restoration Program Plan (ERPP). Stressors addressed have a strong effect on an ecological process, habitat, or a species that is dependent on the Bay-Delta and can be feasibly and sufficiently reduced to improve the health of the Bay-Delta ecosystem. Table 19 identifies important



stressors and the related ERPP Strategic Objective. Strategic Objectives are fixed and will not change through time. Table 20 presents the basis for their selection as an ecosystem stressor.

These visions describe the locations where the stressor has a substantial adverse effect in the ERPP area, and how each stressor affects ecological processes, habitats, and/or species. Restoration needs to reduce the adverse effects of stressors are also identified. The Ecosystem Restoration Program Plan, Volume II: Ecological Management Zone Visions contains more detailed objectives, targets, and programmatic actions for each stressor as it relates to a specific ecological management zone. Table 21 identifies which ecological management zones address which stressors.

Table 19. Strategic Objectives for Stressors.

Stressor	Strategic Objective
Water Diversions	Achieve, first, recovery and then large self-sustaining populations of at-risk native species dependent on the Delta, Suisun Bay, and Suisun Marsh.
	Enhance and/or conserve native biotic communities in the Bay-Delta estuary and its watershed.
	Establish hydrologic regimes in streams, including sufficient flow timing, magnitude, duration, and high flow frequency, to maintain channel and sediment conditions supporting the recovery and restoration of native aquatic and riparian species and biotic communities.
	Establish and maintain hydrologic and hydrodynamic regimes for the Bay and Delta that support the recovery and restoration of native species and biotic communities, support the restoration and maintenance of functional natural habitats, and maintain harvestable species.

Table 19. Strategic Objectives for Stressors (continued).

Stressor	Strategic Objective
Dams and Other Structures	<p>Create and/or maintain flow and temperature regimes in rivers that support the recovery and restoration of native aquatic species.</p> <p>Establish hydrologic regimes in streams, including sufficient flow timing, magnitude, duration, and high flow frequency, to maintain channel and sediment conditions supporting the recovery and restoration of native aquatic and riparian species and biotic communities.</p> <p>Reestablish floodplain inundation and channel-floodplain connectivity of sufficient frequency, timing, duration, and magnitude to support the restoration and maintenance of functional natural floodplain, riparian, and riverine habitats.</p> <p>Restore coarse sediment supplies to sediment-starved rivers downstream of reservoirs to support the restoration and maintenance of functional natural riverine habitats.</p>
Levees, Bridges, and Bank Protection	<p>Reestablish floodplain inundation and channel-floodplain connectivity of sufficient frequency, timing, duration, and magnitude to support the restoration and maintenance of functional natural floodplain, riparian, and riverine habitats.</p>
Dredging and Sediment Disposal	<p>Rehabilitate natural processes to create and maintain complex channel morphology, in-channel islands, and shallow water habitat in the Delta and Suisun Marsh.</p>
Gravel Mining	<p>Restore coarse sediment supply to sediment-starved rivers downstream of reservoirs to support the restoration and maintenance of functional natural riverine, riparian, and floodplain habitats.</p>
Invasive Aquatic Organisms	<p>Eliminate further introductions of new species from the ballast water of ships into the Bay-Delta estuary.</p> <p>Eliminate further introductions of new species from imported marine and freshwater baits into the Bay-Delta estuary and its watershed.</p> <p>Halt the unauthorized introduction and spread of potentially harmful non-native introduced fish and other aquatic organisms in the Bay-Delta and Central Valley.</p> <p>Halt the release of non-native introduced fish and other aquatic organisms from private aquaculture operations and the aquarium and pet trades into the Bay-Delta estuary, its watershed, and other central California waters.</p> <p>Limit the spread or, when possible and appropriate, eradicate populations of nonnative invasive species through focused management efforts.</p>
Invasive Aquatic Plants	<p>Halt the introduction of invasive aquatic and terrestrial plants into the Bay-Delta estuary, its watershed, and other central California waters.</p> <p>Limit the spread or, when possible and appropriate, eradicate populations of non-native invasive species through focused management efforts.</p>

Table 19. Strategic Objectives for Stressors (continued).

Stressor	Strategic Objective
Invasive Riparian and Salt Marsh Plants	<p>Halt the introduction of invasive aquatic and terrestrial plants into the Bay-Delta estuary, its watershed, and other central California waters.</p> <p>Limit the spread or, when possible and appropriate, eradicate populations of non-native invasive species through focused management efforts.</p>
Zebra Mussel	Prevent the invasion of the zebra mussel into California.
Non-Native Wildlife	<p>Reduce the impact of non-native mammals on native birds, mammals, and other organisms.</p> <p>Limit the spread or, when possible and appropriate, eradicate populations of nonnative invasive species through focused management efforts.</p>
Predation and Competition	Ensure that chinook-salmon, steelhead, trout, and striped bass hatchery, rearing, and planting programs do not have detrimental effects on wild populations of native fish species and ERP actions.
Contaminants	<p>Reduce the loadings and concentrations of toxic contaminants in all aquatic environments in the Bay-Delta estuary and watershed to levels that do not adversely affect aquatic organisms, wildlife, and human health.</p> <p>Reduce loading of oxygen-depleting substances from human activities into aquatic ecosystems in the Bay-Delta estuary and watershed to levels that do not cause adverse ecological effects.</p> <p>Reduce fine sediment loadings from human activities into rivers and streams to levels that do not cause adverse ecological effects.</p>
Fish and Wildlife Harvest	<p>Enhance, to the extent consistent with ERP goals, populations of waterfowl and upland game for harvest by hunting and for non-consumptive recreation.</p> <p>Maintain, to the extent consistent with ERP goals, fisheries for striped bass, American shad, signal crayfish, grass shrimp, and nonnative warmwater gamefishes.</p> <p>Enhance fisheries for salmonids, white sturgeon, Pacific herring, and native cyprinid fishes.</p>
Artificial Fish Propagation	Ensure that chinook salmon, steelhead, trout, and striped bass hatchery, rearing, and planting programs do not have detrimental effects on wild populations of native fish species and ERP actions.
Stranding	Reestablish floodplain inundation and channel-floodplain connectivity of sufficient frequency, timing, duration, and magnitude to support the restoration and maintenance of functional natural floodplain, riparian, and riverine habitats.
Disturbance	Contribute to the recovery of at-risk native species in the Bay-Delta estuary and its watershed.